Appraisal Report

Mansfield Hollow Lake Hydropower Study Mansfield, Conn.

DECEMBER 1986

US Army Corps of Engineers
New England Division

EXECUTIVE SUMMARY

This report presents the results of an appraisal study on the addition of a hydropower facility to the existing Corps of Engineers Mansfield Hollow Lake flood control project in Mansfield, Connecticut.

The Mansfield Hollow Lake hydropower study investigated three plans for hydropower development. An economic evaluation determined that none of the plans had a benefit to cost ratio above unity, however, one of the plans had a benefit to cost ratio approximately equal to unity. Alternative 1 would consist of a powerhouse located 650 feet downstream connected to the dam by a steel penstock. The project would have an installed capacity of 950 kilowatts (kw) producing approximately 3,300,000 kilowatt-hours (kwh) of energy per year. The project would have a total investment cost of $5,548,000 resulting in a benefit to cost ratio of 0.98 to 1.0.

The scope of this study permitted only baseline studies of archaeological, environmental, water quality, recreation, social and cultural conditions in the study area. Each of the alternative hydropower developments investigated was compatible with the authorized purpose of this Federal project.

Using current Water Resources Council "Principles and Guidelines" criteria, the addition of a hydropower facility at Mansfield Hollow Lake has been found to have marginal economic justification. The current administration policy on hydropower is to encourage non-Federal development, where feasible, unless non-Federal development is considered impractical. The development of the hydropower potential at Mansfield Hollow Lake could be pursued under the Federal Energy Regulatory Commission (FERC) procedures, consistent with current guidelines. It is the recommendation of this report that no further study be undertaken at Mansfield Hollow Lake at this time. If non-Federal development is found to be impractical at some future time, then the completion of the feasibility study may be warranted.

TABLE OF CONTENTS

TABLES

PLATES

I. INTRODUCTION

STUDY AUTHORITY

This is an appraisal report on the feasibility of adding a hydroelectric generating facility to the Corps of Engineers Mansfield Hollow Lake flood control project on the Natchaug River in the town of Mansfield, Connecticut. Authority for this study is contained in Section 216 of Public Law 91-611 (the River and Harbor Act of 1970).

Under Section 216, the Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of completed projects constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and to improve the quality of the environment in the overall public interest.

STUDY PURPOSE AND SCOPE

The principal reason for this appraisal is to determine whether any economically feasible hydropower development could be undertaken at Mansfield Hollow Lake. Baseline environmental, recreation, social and cultural conditions in the study area have been identified. Due to funding constraints, only run-of-river hydropower plans for development were considered.

STUDY OBJECTIVE

This appraisal report provides a preliminary indication of the potential for hydropower development at Mansfield Hollow Lake. It defines the problems and opportunities of developing hydropower and identifies potential plans of development. The plans were formulated and assessed for social, cultural, environmental and economic impacts. This study was conducted consistent with the "Principles and Guidelines" issued March 10, 1983.

The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment. Hydropower projects contribute to the national economic development. However, most hydropower projects can be planned, constructed and operated by non-Federal interests without Federal assistance. The Federal interest is protected by the Federal Energy Regulatory Commission (FERC) procedures. Accordingly, in most instances, development should proceed under FERC procedures.

Recommendations for continued Federal study would be appropriate only if the proposed facilities would be impractical for non-Federal development or if the FERC procedures could not result in the optimum development of the resource as defined by "Principles and Guidelines." Non-Federal development of a hydropower potential at an existing or proposed Corps project is considered impractical if physical, legal, competing use, institutional, environmental, or economic reasons which would prevent non-Federal development or operation in as productive manner (i.e., produce less NED net benefits of the overall project) as would development by the Federal Government.

OTHER STUDIES

Preliminary permits at Mansfield Hollow Lake have been granted by the Federal Energy Regulatory Commission (FERC) to various developers from March of 1982 to the present. The current holder, Richard D. Ely, was issued a preliminary permit on September 18, 1985 for the purpose of investigating the possible development of the hydropower potential at the Corps of Engineers dam at Mansfield Hollow Lake. The applicant proposed the installation of three hydropower units with an installed capacity of 234 kilowatts (Kw). The applicant proposes placing two of the units in the present stoplog slots in the piers on the front of the dam and the third unit placed within the weir. The applicant was urged to coordinate future investigations through the New England Division of the Corps of Engineers.

II. EXISTING CONDITIONS

PHYSICAL SETTING

The Mansfield Hollow Lake dam is a flood control project owned and operated by the U.S. Army Corps of Engineers. The project is located on the Natchaug River in the town of Mansfield, Connecticut. The dam is located approximately 5.3 miles above the Natchaug River's confluence with the Shetucket River. Mansfield Hollow Lake controls a total drainage area of 159 square miles. A vicinity map is shown on Plate 1.

The important physical components of the project consists of an earth dam, spillway, a concrete weir, outlet works, and storage for recreation and flood control. Pertinent data for the Mansfield Hollow Lake project is summarized in Table 1.

The Mansfield Hollow Lake dam consists of a rolled earthfill embankment with rock slope protection, approximately 14,050 feet in length, with a maximum height above streambed of 62 feet. The top of the dam, at Elevation 273 feet NGVD, provides 11.5 feet of spillway surcharge and 4.5 feet of freeboard. The principal components of the spillway include approach channel, discharge channel and overflow concrete ogee spillway. The spillway is 690 feet long with crest elevation at 257 feet NGVD. There are five rolled earthfill dikes at the north end of the main embankment and one at the east end. The total length of the dikes is 2,650 feet.

The outlet works consist of five 5'-6" wide by 7'-0" high conduits in the concrete spillway section. Conduits 3 and 4 have inverts at Elevation 195.0 feet NGVD and conduits 1, 2 and 5 have inverts at Elevation 199.0 feet NGVD. Each conduit is provided with one hydraulically operated service gate with individual controls. Concrete weirs are located upstream of gates 1 and 2 to maintain the permanent pools at elevation 211.5 feet NGVD. Normal tailwater is controlled by a small stone dam located approximately 300 feet downstream with a crest at Elevation 198.7 feet NGVD. A plan and profile of the outlet works and spillway is shown on plate 2.

Climate

The Natchaug River watershed has an average annual temperature of approximately 47°F, with daily temperatures ranging seasonally from infrequent highs of 100°F to occasional lows below minus 20°F. Temperatures in July and August average 70-71°F and about 22-24°F in January and February. Average annual precipitation over the watershed is approximately 46 inches, uniformly distributed throughout the year. During the winter months, much of the precipitation is in the form of snow, with an average annual snowfall of about 26 inches. Water content of the snow cover accumulates during the winter months reaching an average high of 1.7 inches by mid-February with a maximum some seasons between 5 to 6.5 inches.

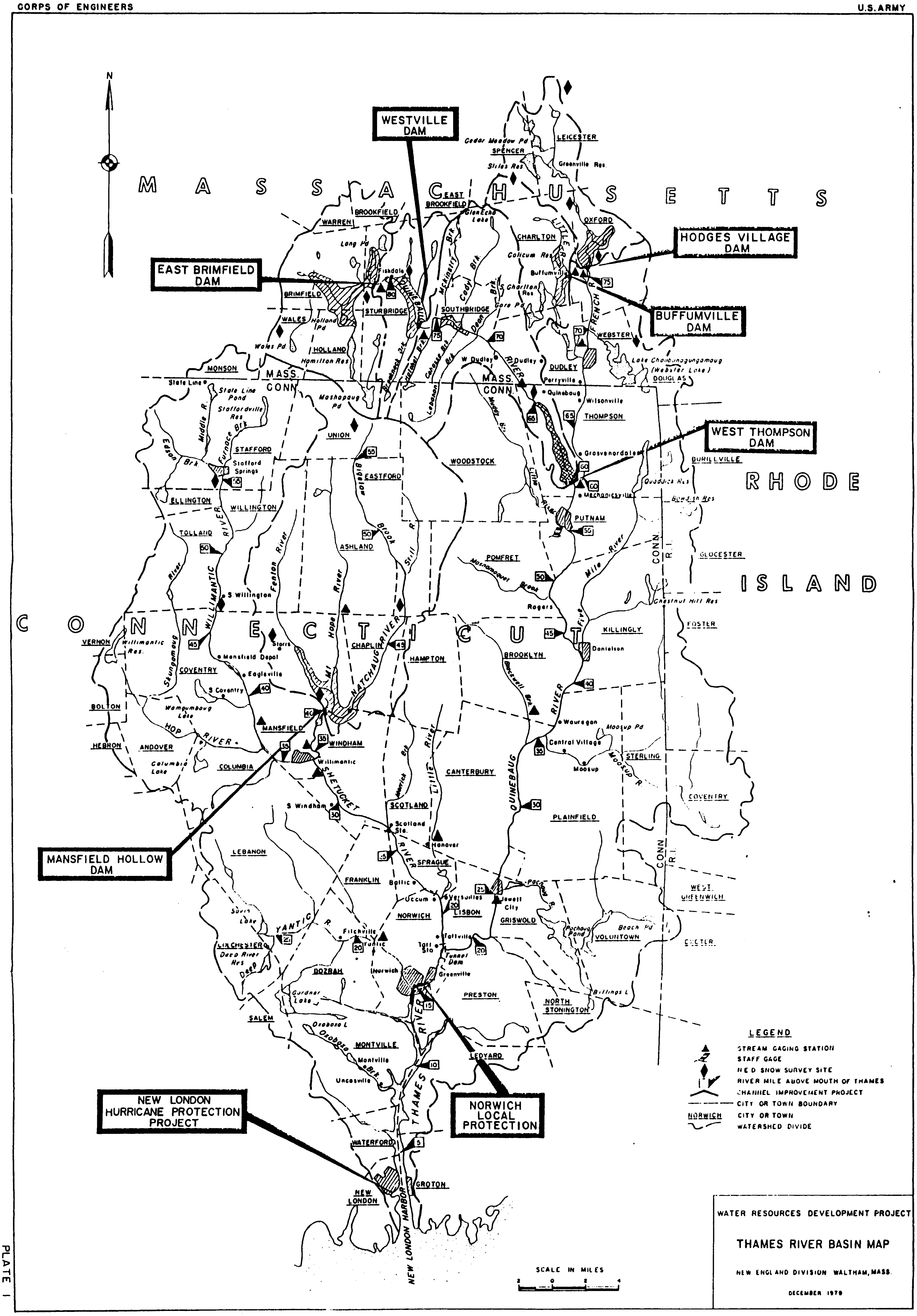

MASSACHUSETTS
CONNECTICUT
RHODE ISLAND
WESTVILLE DAM
EAST BRIMFIELD DAM
HODGES VILLAGE DAM
BUFFUMVILLE DAM
WEST THOMPSON DAM
MANSFIELD HOLLOW DAM
NEW LONDON HURRICANE PROTECTION PROJECT
NORWICH LOCAL PROTECTION
LEGEND
STREAM GAGING STATION
STAFF GAGE
N.E.D. SNOW SURVEY SITE
RIVER MILE ABOVE MOUTH OF THAMES
CHANNEL IMPROVEMENT PROJECT
CITY OR TOWN BOUNDARY
NORWICH CITY OR TOWN
WATERSHED DIVIDE
SCALE IN MILES
WATER RESOURCES DEVELOPMENT PROJECT
THAMES RIVER BASIN MAP
NEW ENGLAND DIVISION WALTHAM, MASS.
DECEMBER 1979

PLATE I

TABLE 1
PERTINENT DATA
MANSFIELD HOLLOW DAM AND RESERVOIR

LOCATION	Natchaug River, Mansfield, Connecticut
DRAINAGE AREA	159.0 Square Miles
STORAGE USES	Flood Control, Recreation, Conservation

RESERVOIR STORAGE

	Elevation (ft, NGVD)	Area (acres)	Acre-Feet	Inches on Drainage Area
Inlet Elevation	195.0	0	0	0.0
Permanent	205.5	200	600	0.07
Conservation Pool	211.5	450	2,200	0.26 (net)
Spillway Crest	257.0	1,880	49,200	5.80 (net)
Max Surcharge	268.0	-	-	-
Top of Dam	273.0	-	-	-

EMBANKMENT FEATURES

Type	Dam and Dike B are rolled earth fill with rock slope protection. All other dikes are random fill with seeded slope
Length (feet)	14,050
Top Width (feet)	15
Top Elevation	273.0 NGVD
Height (feet)	68
Volume (cy)	1,707,000

SPILLWAY

Location	Across the main channel of the Natchaug River
Type	Concrete Ogee
Crest Length (feet)	690
Crest Elevation (feet)	257.0 NGVD
Surcharge (feet)	11.5
Maximum Discharge Capacity (cfs)	106,600

OUTLET WORKS

Type	Five, rectangular conduits
Tunnel Length (feet)	5.5 wide x 7.0 high
Tunnel Diameter (feet)	26 (varies by tunnel)
Service Gate Type	Hydraulically operated sluice
Emergency Type Gates	None (stoplogs only)
D/S Channel Capacity (cfs)	2,900
Max Discharge Capacity at Spillway Crest (cfs)	9,700
Stilling Basin	None (outlet channel training dike)
Weirs	Two control weirs - Gates 1 and 2
Elevation of Gate Sills	Three at 199 feet NGVD, two at 195 feet NGVD

SPILLWAY DESIGN FLOOD

Peak Inflow (cfs)	118,000
Spillway Discharge (cfs)	106,500

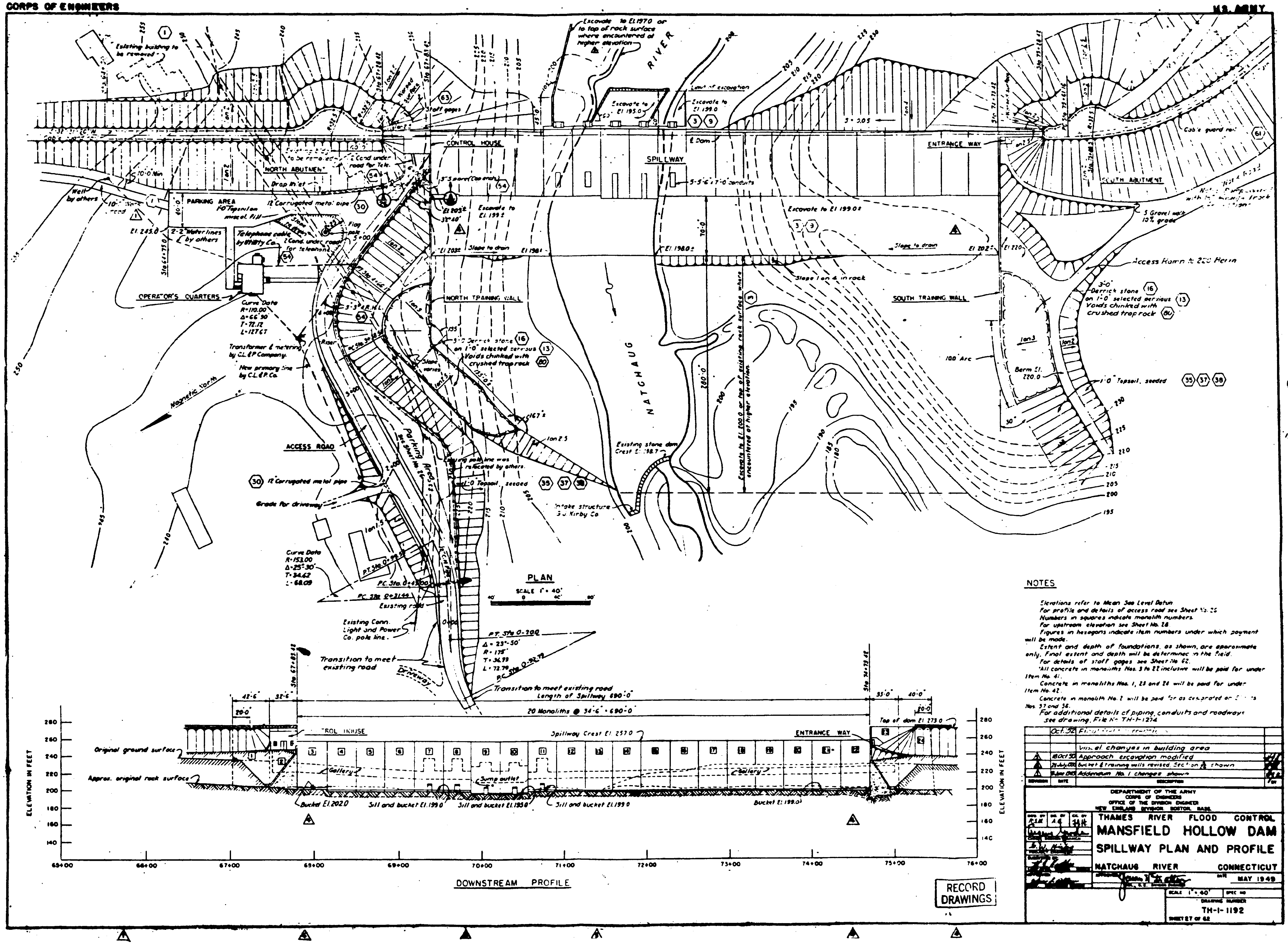

CORPS OF ENGINEERS
U.S. ARMY
CONTROL HOUSE
SPILLWAY
ENTRANCE WAY
NORTH ABUTMENT
SOUTH ABUTMENT
NORTH TRAINING WALL
SOUTH TRAINING WALL
PARKING AREA
OPERATOR'S QUARTERS
ACCESS ROAD
NATCHAUG
RIVER
Magnetic North
PLAN
SCALE 1" = 40'
NOTES
Elevations refer to Mean Sea Level Datum
Numbers in squares indicate monolith numbers.
Figures in hexagons indicate item numbers under which payment will be made.
Extent and depth of foundations, as shown, are approximate only. Final extent and depth will be determined in the field.
For additional details of piping, conduits and roadways see drawing, File No. TH-1-1274
Length of Spillway 690'-0"
20 Monoliths @ 34'-6" = 690'-0"
Spillway Crest El. 257.0
Original ground surface
Approx. original rock surface
ELEVATION IN FEET
DOWNSTREAM PROFILE
Approach excavation modified
Addendum No. 1 changes shown
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.
THAMES RIVER FLOOD CONTROL
MANSFIELD HOLLOW DAM
SPILLWAY PLAN AND PROFILE
NATCHAUG RIVER CONNECTICUT
MAY 1949
TH-1-1192
RECORD DRAWINGS

PLATE 2

Watershed

The Natchaug River watershed is a subwatershed within the Thames River Basin. The Natchaug River is approximately 16 miles long, with a total fall of 763 feet, and a drainage area of 174 square miles at its confluence with the Shetucket River.

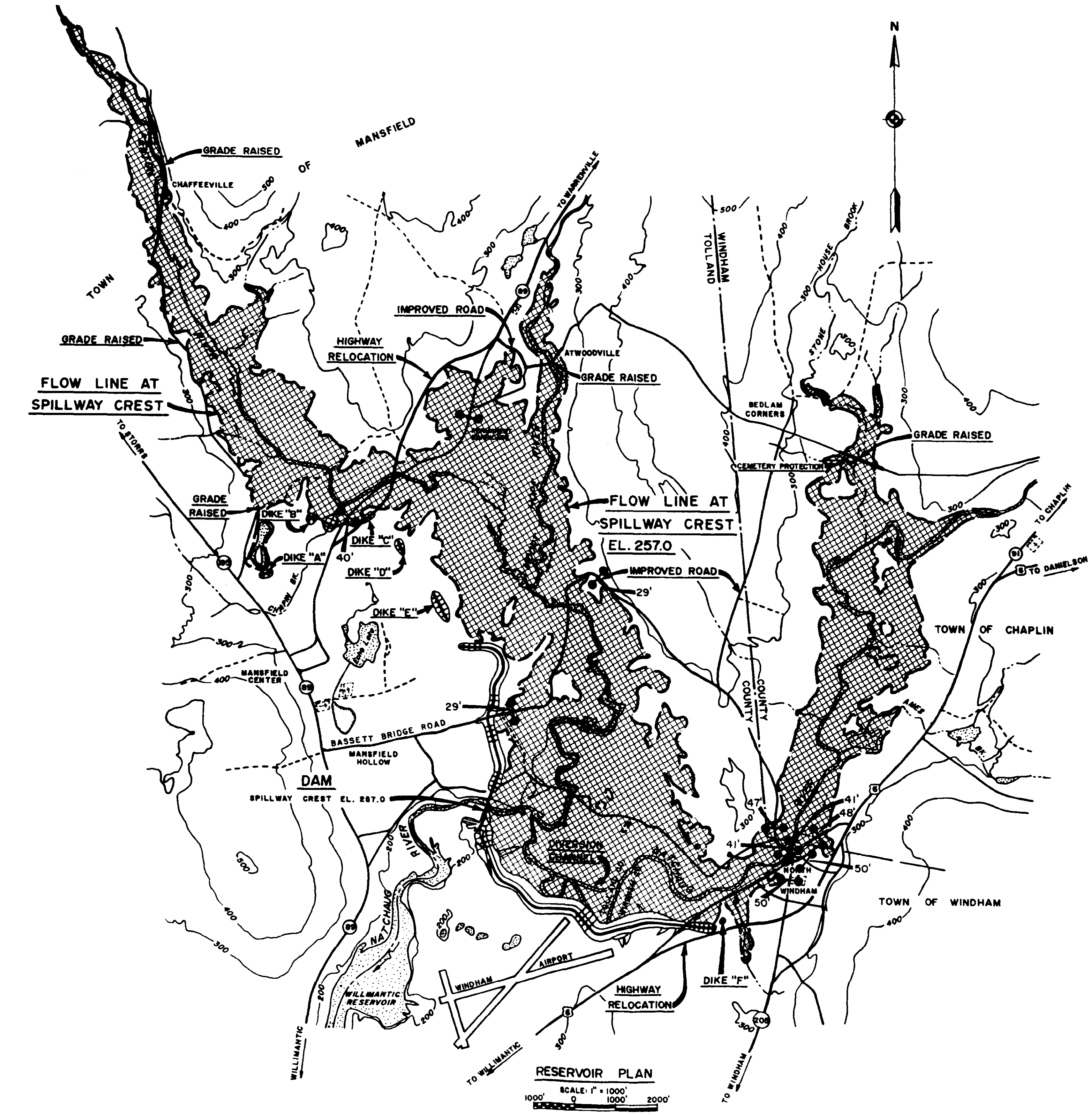
Mansfield Hollow Lake is located on the Natchaug River approximately 5.3 miles upstream of its mouth. The project controls a total drainage area of 159 square miles. A reservoir map is shown on Plate 3.

Streamflow

A U.S. Geological Survey gaging station located on the Natchaug River, approximately 3.7 miles downstream of the dam has recorded river discharges since 1931. Flows at the gage were prorated by the drainage area ratio (gage DA = 174 square miles) to reflect discharges from the dam (DA = 159 square miles). The average flow at Mansfield Hollow Lake is about 277 cubic feet per second (cfs). Average annual runoff at the site is approximately 23.5 inches, or 51 percent of the annual precipitation, and is equivalent to an average runoff rate of 1.7 cfs per square mile of the total drainage area. Table 2 lists average monthly recorded flows over the past 53 years. A flow duration curve based on daily flow data for the period of record (1931-1983) is shown on Plate 4.

Reservoir Storage

Mansfield Hollow Lake contains storage for flood control and recreation. A recreation pool at Elevation 211.5 NGVD is currently maintained by concrete weirs located upstream of gates 1 and 2. The recreation pool of 211.5 feet NGVD is lowered to approximately elevation 206 during the winter months. The recreation pool has a surface area of 450 acres and includes a storage of 2,800 acre-feet equivalent to 0.33 inches of runoff. The flood control storage contains 49,200 acre-feet when filled to spillway crest (Elevation 257.0). This is equivalent to 5.8 inches of runoff from a total drainage area of 159 square miles. An area-capacity table is shown in Table 3.



THAMES RIVER FLOOD CONTROL
MANSFIELD HOLLOW DAM

RESERVOIR MAP
WITH ROAD BARRICADES

NATCHAUG RIVER CONNECTICUT

JAN 1980

PLATE 3

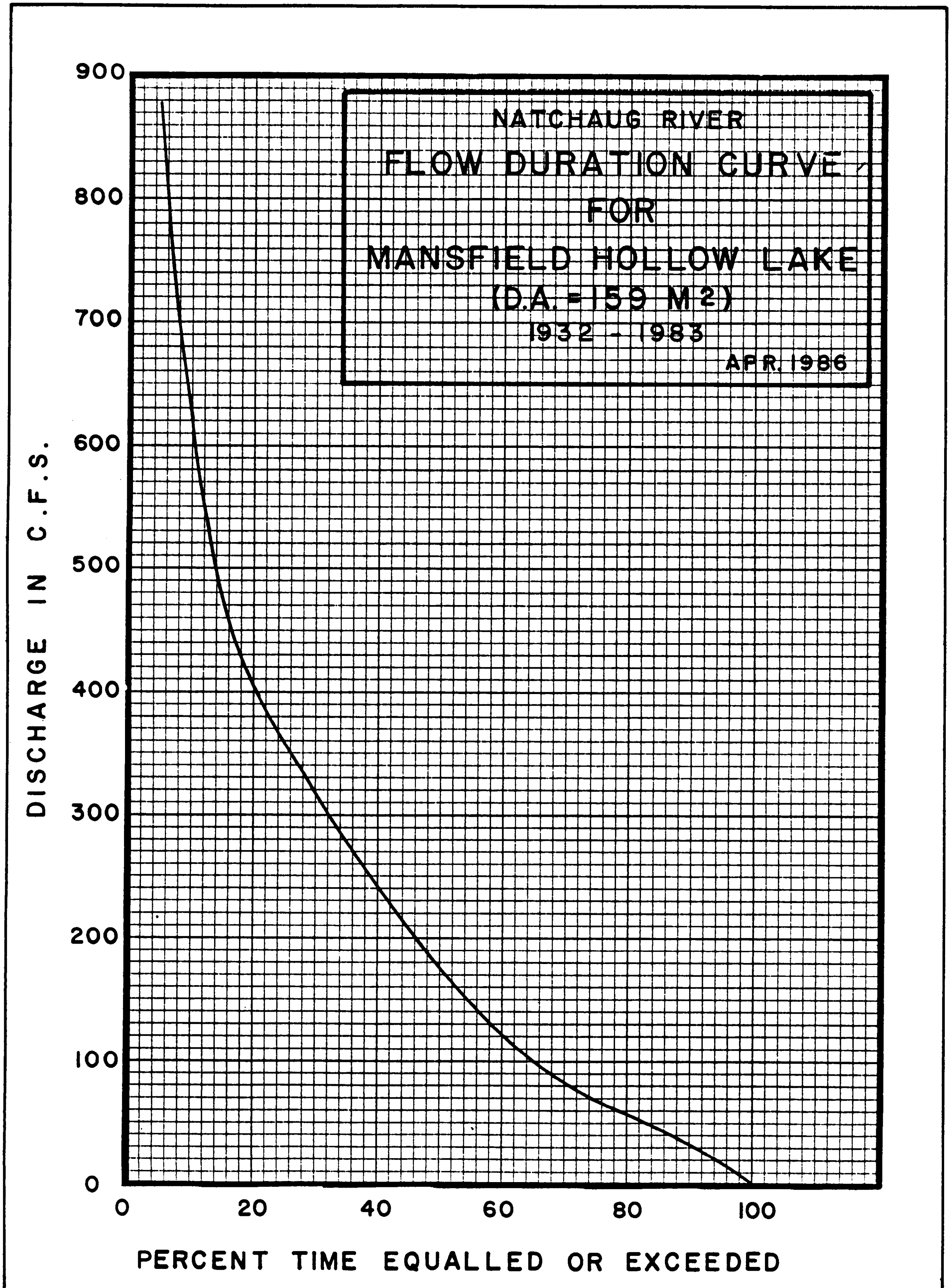

NATCHAUG RIVER
FLOW DURATION CURVE
FOR
MANSFIELD HOLLOW LAKE
(D.A.=159 M2)
1932 - 1983
APR. 1986
DISCHARGE IN C.F.S.
900
800
700
600
500
400
300
200
100
0
0
20
40
60
80
100
PERCENT TIME EQUALLED OR EXCEEDED

TABLE 2

AVERAGE MONTHLY FLOWS (1931-1983)
NATCHAUG RIVER AT MANSFIELD HOLLOW LAKE
(Drainage Area = 159.5 Square Miles)

Month	Average Flow		Annual Percent Runoff	Maximum Monthly		Minimum Monthly	
	cfs	Inches		cfs	Inches	cfs	Inches
January	345	2.50	10.6	1,007	7.81	56	0.41
February	364	2.38	10.1	847	5.55	81	0.53
March	573	4.15	17.6	1,530	11.09	277	2.01
April	524	3.68	15.6	1,136	7.97	207	1.45
May	320	2.32	9.9	582	4.22	108	0.78
June	205	1.44	6.1	1,181	8.29	32	0.22
July	96	0.69	2.9	807	5.85	11	0.08
August	81	0.59	2.5	761	5.52	9	0.06
September	120	0.84	3.6	1,386	9.73	10	0.07
October	137	0.99	4.2	801	5.81	17	0.12
November	238	1.67	7.1	768	5.39	41	0.29
December	316	2.29	9.7	863	6.26	64	0.46
Annual	277	23.54		978	83.49	76	6.48

TABLE 3

MANSFIELD HOLLOW RESERVOIR
AREA AND CAPACITY

Drainage Area: 159 Sq. Mi.

Elev. (NGVD)	Stage (ft.)	Area (acres)	Capacity (ac.ft.)	Capacity (inches)
Permanent Storage				
195	0	0	0	0
196	1	0	0	0
197	2	5	0	0
198	3	8	0	0
199	4	18	0	0
200	5	25	20	0
201	6	70	55	0.01
202	7	100	135	0.02
203	8	130	250	0.03
204	9	165	400	0.05
205	10	200	580	0.07
206	11	240	800	0.09
207	12	280	1,060	0.12
208	13	325	1,365	0.16
209	14	370	1,715	0.20
210	15	415	2,120	0.25
211	16	440	2,545	0.30
211.5	16.5	450	2,800	0.33
Flood Control Storage				
211.5	16.5	450	0	0
212	17	465	200	0.02
213	18	490	680	0.08
214	19	515	1,180	0.14
215	20	540	1,710	0.20
216	21	565	2,200	0.26
217	22	595	2,840	0.33
218	23	620	3,450	0.41
219	24	650	4,080	0.48
220	25	675	4,750	0.56
221	26	690	5,430	0.64
222	27	710	6,130	0.72
223	28	740	6,850	0.81
224	29	760	7,600	0.90
225	30	785	8,400	0.99

Elev. (NGVD)	Stage (ft.)	Area (acres)	Capacity (ac.ft.)	Capacity (inches)
Flood Control Storage (cont.)				
226	31	810	9,200	1.10
227	32	835	10,000	1.18
228	33	855	10,800	1.27
229	34	880	11,700	1.38
230	35	900	12,600	1.49
231	36	925	13,500	1.59
232	37	955	14,450	1.70
233	38	980	15,400	1.82
234	39	1,015	16,400	1.93
235	40	1,040	17,450	2.05
236	41	1,070	18,500	2.18
237	42	1,095	19,600	2.31
238	43	1,125	20,700	2.44
239	44	1,160	21,800	2.57
240	45	1,190	23,000	2.71
241	46	1,225	24,200	2.85
242	47	1,260	25,450	3.00
243	48	1,295	26,700	3.15
244	49	1,330	28,000	3.30
245	50	1,360	29,400	3.47
246	51	1,400	30,800	3.63
247	52	1,450	32,200	3.80
248	53	1,490	33,700	3.97
249	54	1,530	35,200	4.15
250	55	1,580	36,700	4.33
251	56	1,625	38,300	4.52
252	57	1,670	40,000	4.71
253	58	1,710	41,600	4.91
254	59	1,750	43,400	5.12
255	60	1,790	45,400	5.35
256	61	1,840	47,200	5.57
257	62	1,880	49,200	5.80

NOTES: Gate Sill Elevation = 195 NGVD
Spillway Crest Elevation = 257 NGVD
1" Runoff = 8,480 acre-feet

ENVIRONMENTAL SETTING

Water Quality

The Mount Hope, Fenton, and Natchaug Rivers above Mansfield Hollow Lake are rated class AA by the Connecticut Department of Environmental Protection (DEP). Class AA ratings are for existing or proposed drinking water supply impoundments and tributary surface waters. Technical requirements for class AA waters include a minimum dissolved oxygen concentration of 5 mg/l; fecal coliform bacteria not to exceed an arithmetic mean of 20 per 100 ml nor more than 100 per 100 ml in more than 10 percent of the samples; sodium not to exceed 20 mg/l; and no color, turbidity, pH, phosphorus, taste or odor except as naturally occurs. The waters shall be free from chemical constituents in concentrations or combinations which would be harmful to human, animal, or aquatic life for the most sensitive water use.

Water quality conditions have not changed significantly during the 15 years the Corps has collected data at Mansfield Hollow Lake. This is due to the small amount of development taking place upstream. There are no significant point-source discharges in the watershed, and the waters are in excellent condition according to the Connecticut DEP. Nutrient levels are low enough that, combined with the short hydraulic detention time, algal blooms do not form in the lake.

Water quality monitoring by the Corps has confirmed the generally good water quality in the lake, but has also found some instances where low pH, high coliform bacteria levels, and elevated heavy metal levels have exceeded the desirable limits for class AA waters. These conditions are not severe enough to affect the project's use for recreation or aquatic habitat, but do warrant continued watching.

With a maximum depth of 16.5 feet and a mean depth of only 6 feet, the reservoir is too shallow to stratify strongly; however, mild stratification patterns can form, break up, and reform during the summer. On hot sunny days, temperature differences of over 10 degrees Fahrenheit can exist between the surface and bottom of the lake. Mild stratification can persist long enough for the DO to be depleted at the bottom of the lake. These low DO levels do not affect downstream conditions, however, because normal releases from the reservoir are made over a weir.

Aquatic Environment

The aquatic habitats of the Mansfield Hollow Lake Project area include both lotic and lentic habitats. Mansfield Hollow Lake is maintained at 16.5 feet in depth and covers 450 acres during the period from May to November. During the winter season an 11.5 foot deep pool is maintained. The lake is classified an Lacustrine-Limnetic-Open-Water Permanent with small areas of Lacustrine-Littoral-Aquatic bed-Permanent by the U.S. Fish and Wildlife Service, National Wetlands Inventory. The major game fish at Mansfield Hollow Lake is largemouth bass (Micropterus salmoides), smallmouth bass (M. dolomieui) and chain pickerel (Esox niger) are also present. The major lotic habitats are Fenton River, Mount Hope River, and Natchaug River. Fenton River and Mount Hope River are classified Riverine - Lower perrenial-Open water-Permanent. Natchaug River is classified Riverine-Upper perennial-Open water-Permanent.

The Connecticut Department of Environmental Protection, Fisheries Unit stocks brown (Salmo trutta), rainbow (S. gairdneir), and brook trout (Salvelinus fontinalis) into these riverine habitats. Native brook trout are likely present in the tributaries to these streams.

Terrestrial Ecosystem

The Mansfield Hollow Lake Forest Management Plan describes the terrestrial and wetland habitats of the project as follows: About three-fourths of the land in the towns of Mansfield, Chaplin, and Windham is wooded, including about 50 percent of the reservoir area. Most of the woodland varies in density and tree sizes, indicating recent regeneration following some previous use, such as agriculture or logging. The predominant tree species in the floodplain and swamp woodlands are red maple (Acer rubrum), gray birch (Betula populifolia), red oak (Quercus rubra), American elm (Ulmus americana), and sugar maple (Acer saccharum). The shrub swamps of the reservoir consist largely of red-osier dogwood (Cornus stolonifera), meadowsweet (Spirea latifolia), steeple bush (S. tomentoa), alder (Alnus rugosa) and black alder (Ilex verticillata). The herbaceous plants of marshes and wet meadows are tussock sedge (Carex stricta) and other sedges, grasses, rushes, and ferns. The upland woods in the reservoir area occur mostly on dry sandy soil and consist predominantly of red and white oak and white pine.

Major wildlife of the project include white-tailed deer (Odocoileus virginianus), cottontail rabbit (Sylvilagus floridanus), mink (Mustela vison), woodchuck (Marmota monax), grey fox (Urocyon cinereoargenteus), red fox (Vulpes fulva), oppossum (Didelphis virginiana), voles (Microtus spp.) and mice (Peromyscus spp.).

Upland game bird species are ruffed grouse, ringnecked pheasant, and bobwhite quail. Waterfowl in the area include Canada geese, mallard, black duck, and wood duck. Non-game birds include red-tailed hawk, common loon, herring gull, cattle egret, migrating shorebirds, mockingbird, cardinal, and wintering sparrows and finches.

Some species of reptiles and amphibians found including snapping (Chelydra serpentina), painted (Chrysemys picta), and spotted turtles (Clemmys guttata), water snake (Nerodia sipedon), garter snake (Thamnophis sirtalis), hognose snake (Heterodon platyrhinos), and green snake (Opheodrys vernalis), bullfrog (Rana catesbeiana), green frog (R. clamitans melanota), and leopard frog (Rana sp.), redbacked salamander (Plethodon cinereus), and newt (Notophthalmus viridescens).

RECREATION RESOURCES

The 2,472 fee-owned acres of Mansfield Hollow Lake are open to the public for recreational usage. Recreational facilities are provided and managed by the Connecticut Department of Environmental Protection on a day use basis. A picnic area, rest rooms, ballfields, and parking areas are the available facilities. General recreational activities include fishing, hunting, hiking, boating and trails.

HISTORICAL AND ARCHAEOLOGICAL RESOURCES

An examination of mid- 19th century maps reveals no recorded historic period resources below Elevation 213 feet NGVD. No prehistoric resources are recorded within the project boundaries. Unrecorded prehistoric and historic sites may be present.

SOCIOECONOMIC SETTING

Mansfield Hollow Lake is located on the Natchaug River in Mansfield, Connecticut about 5.3 miles above the confluence with the Shetucket River. Much area around the dam and lake is rural with the exception of the town of Mansfield.

Most of the employment opportunities within the Mansfield area are based on manufacturing. There was a steady growth in employment between 1960 and 1970 in the area around the dam mainly due to prospering businesses. These businesses employed the majority of people who lived in the area surrounding Mansfield Hollow Lake.

In 1975-1976, a small business recession hit the area and caused a decline in basic manufacturing, which included businesses on the Natchaug River in the Mansfield Hollow Lake region. Many of the businesses in the Mansfield area, as well as the rest of the Northeast, once again prospered as a result of government spending in defense. Much of the employment is dependent upon manufacturing in the region. Most of the jobs and major source of employment within the river basin itself is dependent on these manufacturing firms.

Although the basin is dependent on manufacturing for its economic well-being, the town of Mansfield still remains a rural community. The population estimate for Mansfield in July 1984 was 20,117. The average per capita income in Mansfield is $7,376.

RESERVOIR REGULATION

The principal purpose of the Mansfield Hollow project is flood control. Mansfield Hollow dam is operated to protect the primary damage centers of Mansfield and Willimantic, Connecticut. It is also operated in conjunction with four supporting reservoirs on the upper Quinebaug and

French Rivers that control flood flows at downstream damage centers. The coordination of the five reservoirs is covered in the Thames River Basin Master Manual. The Mansfield Hollow Lake project includes a permanent pool approximately 16.5 feet deep, maintained by two box-shaped concrete weirs located upstream of the first two gates. The three remaining gates are normally closed to allow the inflow to be discharged over the weir. The recreational pool at elevation 211.5 feet NGVD is increased to 213 feet NGVD during the spring to maintain the recreational pool as long as possible. The increased pool level is maintained as long as flow conditions

During flood conditions, the flood control gates at Mansfield Hollow are throttled or closed to reduce flood stages on the Natchaug and Thames Rivers. Regulated releases at the dam are coordinated with conditions at the East Brimfield, West Thompson, Hodges Village and Buffumville dams to provide optimum utilization of the Thames River flood control system. A minimum release of about 20 cfs is maintained during periods of flood regulation in order to sustain downstream fish life.

Following the recession of a flood peak on the Natchaug River, the reservoir is emptied as rapidly as possible in accordance with the regulation guidelines established for the Thames River basin.

It is the policy of the Corps of Engineers to cooperate with downstream water users and other interested parties or agencies. The Project Manager may be requested to deviate from normal regulations for short periods. Whenever such a request is received, the manager shall ascertain the validity of the request and obtain assurances from other downstream water users that they are agreeable to the modified operation.

III. PROBLEM IDENTIFICATION

PROBLEM IDENTIFICATION AND OPPORTUNITIES

The preservation of a dependable, inexpensive supply of electricity has long been recognized as an important commodity to the people of New England and to the economy of the region. To meet this need the New England Power Pool (NEPOOL) was established in 1971 by the majority of New England's electrical utilities to enhance the performance and efficiency of their numerous generating facilities. NEPOOL utilizes an extensive computer and communications network to coordinate the production of electricity at the various types of installations to increase the overall efficiency of their system and minimize the required reserve capacity. This optimization of the overall generation network results in a lower cost of electricity.

The demand for electrical energy varies significantly depending upon the time of year and the time of day. The amount of electricity demanded by consumers during the peak period of the day may drastically exceed the demand during the low period of the day. Because consumers' habits tend to be similar, however, this rise and fall in demand is reasonably predictable. The NEPOOL utilizes numerous types of generating facilities to meet these diversified demands on the system. The selection of the type of plant is based on the type of load the plant will serve and the availability, cost and special characteristics of each fuel. Certain plants, such as nuclear, operate continuously to meet the constant, base load, portion of the system demand. A second type of plant produces the energy required to provide the intermediate level demands resulting from the greater daytime energy use. A third type of plant, called a peaking plant, is used to handle the rapid upsurges in demand that occur during the peak times of each day.

In 1983, nuclear plants provided one-third of New England's energy generation. Based on NEPOOL's latest forecast of energy demand and generating capability, nuclear power is expected to provide about half of the region's generation by 1993. Despite the increasing reliance on nuclear generation, fossil-fueled plants continued to supply 60 percent of the New England's energy requirements in 1983. Current forecasts indicate that by 1993 fossil-fueled generating plants will account for approximately 43 percent of New England's energy mix.

The instability of oil supplies, coupled with unstable market prices, has encouraged the expanded use of alternative energy sources. One alternative to fossil-fueled generation is hydropower. In 1983 hydropower generation provided only six percent of the utility generation compared to 35 percent in the mid-1940's. The increased usage of nuclear plants and other more efficient and dependable generation facilities had reduced the impact of hydropower generation in New England. However, the dramatic increase in the cost of fossil fuel, combined with the national incentives to reduce the nation's fossil-fuel usage, has stimulated an increased interest in constructing small hydropower projects and refurbishing some of the previously retired small hydropower installations.

Development of the hydropower potential at the Mansfield Hollow Lake project provides an opportunity to develop a safe, dependable, environmentally attractive, relatively inexpensive source of electricity within the constraints of the existing reservoir area and existing project purposes. The savings in cost of power production could be realized by several hundred households. The conservation of fossil fuel can be measured in thousands of barrels of oil annually. This project is an opportunity to contribute to solving the continuing problem of New England's dependence on oil-generated electricity.

FUTURE CONDITIONS WITHOUT THE PROJECT

No significant changes in the physical, environmental, cultural, social, or economic conditions are envisioned in the study area. No significant changes in reservoir regulation are expected. However, the projected gradual increase in population could result in subtle changes to the environment and water quality of the river.

PLANNING CONSTRAINTS

Planning constraints are conditions imposed upon the planning process that limit the range of feasible alternatives available to the planner. These constraints may consist of legal, social, and environmental factors of such importance that violating them would compromise the entire planning effort. In the design of any hydroelectric generating facility, measures must be taken to minimize environmental and social disruptions and still optimize the power potential of the site.

The primary purpose for the Mansfield Hollow Lake project is flood control. Any hydropower addition to this project must not interfere with flood control operations. For the purpose of this report, a maximum pool elevation of 213 feet NGVD was assumed. Elevation 213.0 feet NGVD is considered the maximum reservoir encroachment without significant impact on the flood control operation of the project. Hydrologic studies regarding significant infringement on existing flood control storage, impacts on reservoir regulation activities and water quality, as well as detailed design and cost estimates, are beyond the scope of this reconnaissance investigation. Future studies would include detailed hydrologic, water quality and regulation considerations to determine whether any infringement on flood control storage would have a significant adverse impact on the Thames River Basin flood control system. For this report, assumptions have been based on the premise that the Corps of Engineers would plan, develop, construct and operate any hydropower additions to the project.

Tailwater rating curves derived for the Mansfield dam outlet gates were calculated assuming that the gates would be fully open. In normal practice, these gates are set to limit the flood flows from a sudden flood event. Further investigations would be required to determine what restrictions this would place on the hydropower operation.

During the flood control operation at Mansfield Hollow Lake, all flood control gates are throttled or closed to reduce downstream flood stages. Once the flood peak on the river recedes, the reservoir is emptied as rapidly as possible in accordance with established guidelines. For this study, it was assumed that the hydropower installation would not operate during flooding conditions.

It is the policy of the Federal Government to encourage non-Federal interests to develop the hydropower potential of existing Federal water resources projects where feasible and to only pursue Federal hydropower development where non-Federal activity is impractical. In accordance with this policy, it is the practice of the Corps of Engineers to suspend all hydropower activities at Corps-owned projects if a Federal Energy Regulatory Commission (FERC) license is issued to a non-Federal entity for the same project or if the Federal development of energy at a Corps project would adversely impact on a planned or existing non-Federal hydropower project. The suspension of a project under investigation would consist of concluding the study in a logical and rational fashion in accordance with current reporting regulations. Federal development should only be pursued if there are physical, operational, legal, competing use, institutional, environmental, or economic reasons which would reasonably be expected to prevent non-Federal development or operation of the hydropower resource in as productive a manner as a project developed by the Federal Government. In keeping with this practice, the Corps of Engineers, New England Division, would pursue future hydropower studies only if non-Federal development could not be accomplished without impacting the existing flood control project.

IV. PLAN FORMULATION

The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment. The protection of the Nation's energy economy from the unstable world oil market has prompted the desire to reduce petroleum dependent energy generation through the better utilization of our natural resources. Sources of alternative energy include coal, nuclear, solar, water and wind.

Coal and nuclear energy are presently used for base load and intermediate energy generation, but are inadequate for the fluctuating peak demands. In addition, the construction of new coal facilities are hampered by transportation limitations and environmental protection requirements, while the current social-political climate in New England makes development of future nuclear projects unclear. Solar and wind energy generation are potential alternatives, however, practical applications are present only at small scales of development. Hydroelectric development, if cost effective, would provide a viable substitute to oil-fired generation.

PLAN FORMULATION RATIONALE

The purpose of this investigation is to determine the feasibility of adding hydroelectric generating facilities to the Mansfield Hollow project. In view of the limited scope of this appraisal effort and the inherent hydrologic and hydraulic constraints, it was decided that only run-of-river hydropower alternatives would be considered at this time. The different schemes investigated are intended to displace the output of a combined cycle oil-fired thermal facility. The schemes are designed to be operated as run-of-river projects, thereby minimizing fluctuations of the reservoir level during hydropower operations. Hydropower operations which utilize temporary storage to increase energy generation were not considered due to their possible conflict with the flood control operation.

The hydropower potential of a volume of water is a function of its weight and the vertical distance it can be lowered. The function of a water power facility is to transform this gravitational potential energy into mechanical energy, by turning a turbine, thence into electrical energy via a generator. The rate of power generation, normally measured in kilowatts, is determined by the formula:

$$P = \frac{EHQ}{11.8}$$

where

P = Power of capacity in kilowatts
E = Combined turbine and generator efficiencies
Q = Rate of discharge in cubic feet per second
H = Net hydraulic head in feet

With today's highly efficient turbines and generators, an average combined efficiency of 80 percent can be reasonably assumed for a typical range of operating head and discharge conditions. The potential amount of energy generation over a period of time is normally measured in kilowatt-hours and is equal to the average capacity times the duration of generation.

The potential amount of water power of any stream is a function of the average streamflow and the average annual hydraulic head. Both the rate of discharge and the head are quantities which may fluctuate, therefore, it is the magnitude of these two quantities and their variability that determines the potential energy of a site and its dependability.

There are both flow and head limitations on the operating capability of hydraulic turbines. The upper and lower turbine flow limits are typically expressed as a function of the design discharge, i.e., the flow that will produce the maximum turbine output at the design head. The allowable operating range of a turbine is determined by the type of turbine and its characteristics. The operating limits of the selected turbine are plotted on the flow duration curve. The area under the curve enclosed by these limits establishes the theoretical average flow available to the turbine 100 percent of the time. This flow is converted into an average power output from the previously described power equation multiplied by 8,760 hours in a year, giving the average annual energy, in kilowatt-hours, which could be generated by a plant of the assumed capacity.

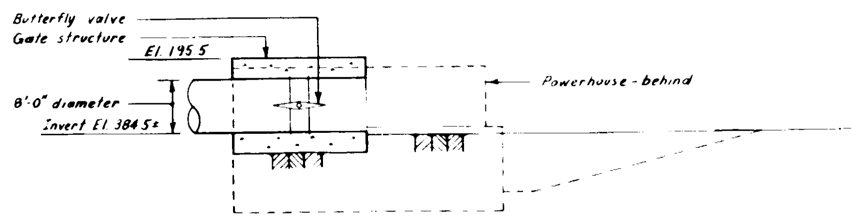
DESCRIPTION OF HYDROPOWER ALTERNATIVES

Various alternatives were formulated to evaluate the economic feasibility of developing the hydropower potential at Mansfield Hollow Lake. Both conventional, downstream hydropower developments and submersible installations located within the dam's impoundment, were considered for this site. The maximum pool elevation of 213.0 feet NGVD was used for all hydropower alternatives since the current recreation pool is periodically maintained close to this elevation. The installed capacity for the conventional downstream hydropower project was optimized using the Corps of Engineers HYDUR (Hydropower Analysis Using Streamflow Duration Procedures) computer program. The installed capacities of the submersible micro-installations were determined using information obtained from manufacturers' literature.

Alternative 1 consists of a powerhouse containing two units located on the right bank approximately 650 feet downstream of the dam. The powerhouse would be connected to the dam by an 8-foot diameter steel penstock. Two conduits were required to convey the flows to the powerhouse in order to eliminate a vortex problem and to minimize the head losses in the outlet conduits. The project would have an installed capacity of 950 kilowatts (Kw) under a gross head of 29.5 feet and a net head of 23 feet. The project would produce approximately 3,300,000 kilowatt-hours (kWh) of energy annually with a design flow of approximately 600 cfs. Pertinent data for this alternative is provided in Table 4. A conceptual design of the downstream hydropower installation is shown in Plate 5.

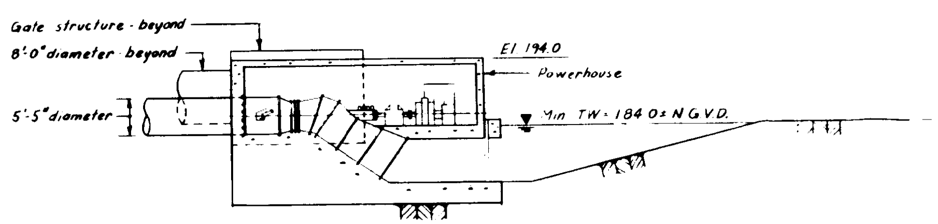
The increased interest in small hydropower applications has led to the manufacturing of small, self-contained, turbine/generators designed to operate, fully submerged, under low flow and head conditions. This concept allows the installation of small, unmanned hydropower facilities at existing dams which previously were considered inappropriate for hydropower retrofit projects. This type of unit was considered as a practical alternative which could be economically feasible at Mansfield Hollow Lake. The unit would be located in a reinforced concrete weir, within the impoundment area, connected to the dam's outlet structure. The submersible hydropower installation would utilize the head differential between the surface elevation of the pool and the tailwater elevation within the weir bay to generate electricity. The flows which do not pass through the hydropower unit are discharged over the weir. Under these conditions, the tailwater elevation in the weir bay is dictated by the hydraulic capacity of the weir structure to discharge flows through the gate passage. This method of operation would not place the dam's outlet conduit under pressure and would negate the Corps of Engineers requirement to insert a tunnel liner within the outlet works. A tailwater rating curve for this installation scheme is shown on Plate 6.

The submersible installations consist of inclined mounting of the turbine/generators in new enlarged concrete weirs replacing the existing structures. Permanent access to the units would be accomplished by constructing an embankment between the right bank and the new weir wall. Alternative 2 would consist of two units placed in a concrete weir encompassing the first two gate intakes. The project would have an installed capacity of 85 Kw under a design head of 11 feet and a design flow of 136 cfs. The project would produce approximately 393,000 kWh of energy annually. Alternative 3 would consist of a single unit located in a concrete weir around gate 1. This installation scheme would utilize the existing concrete weir in front of gate 2 to provide additional discharge capacity, resulting in an increased range for power generation. This project would have an installed capacity of 42.5 Kw with a design head of 11 feet. The project would produce approximately 250,000 kWh per year utilizing a design flow of 68 cfs.



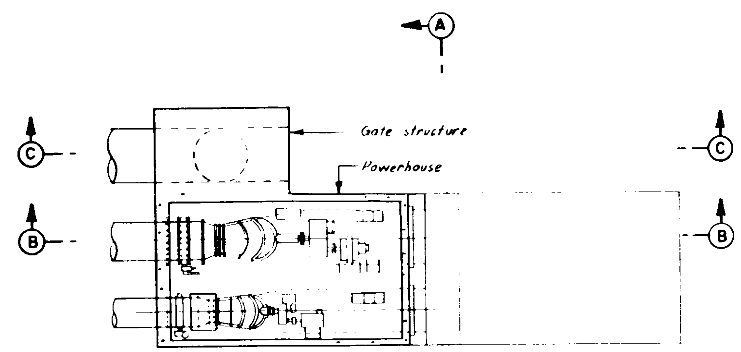
SECTION C-C

SCALE: 1" = 10'



SECTION B-B

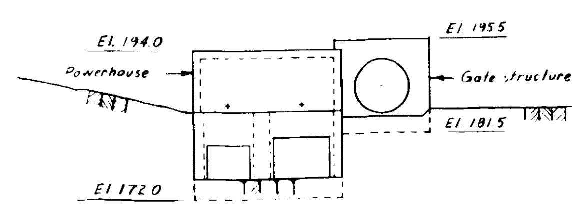
SCALE: 1" = 10'



POWERHOUSE AND GATE STRUCTURE
PLAN

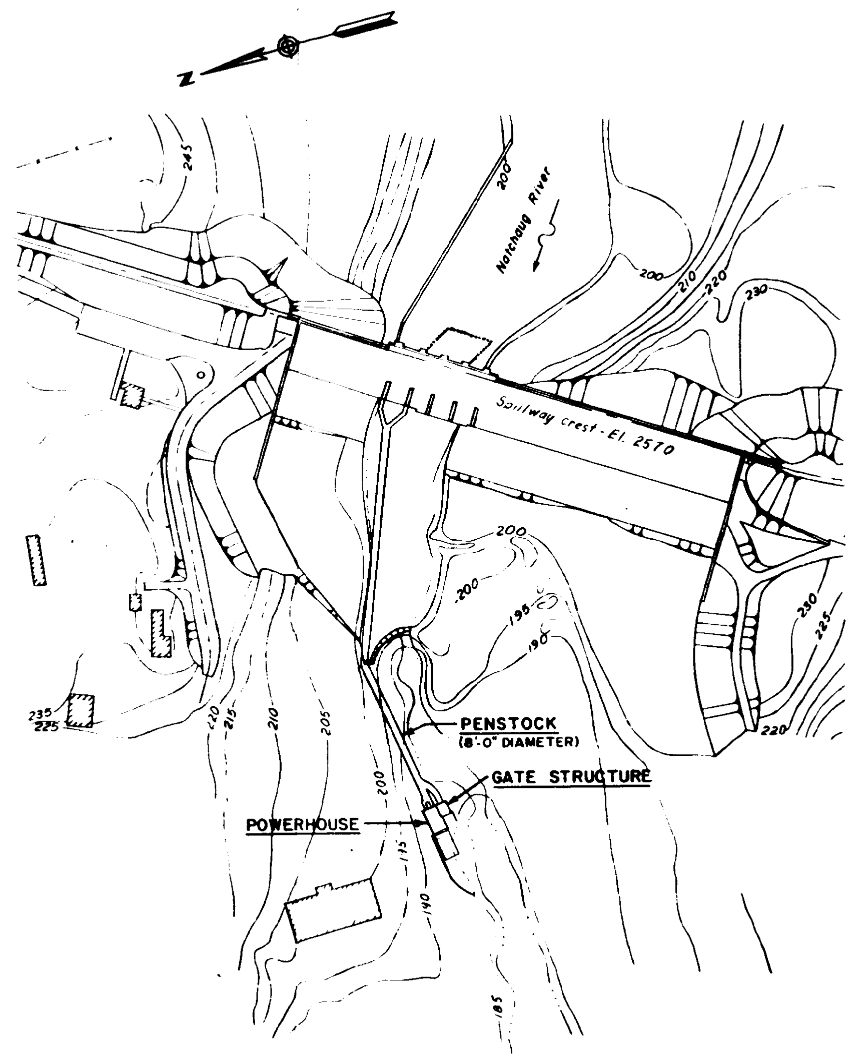
SCALE: 1" = 10'

A



SECTION A-A

SCALE: 1" = 10'



GENERAL PLAN

SCALE: 1" = 100'

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HYDROPOWER RECONNAISSANCE STUDY

THAMES RIVER BASIN

MANSFIELD HOLLOW LAKE

HYDROPOWER INSTALLATION

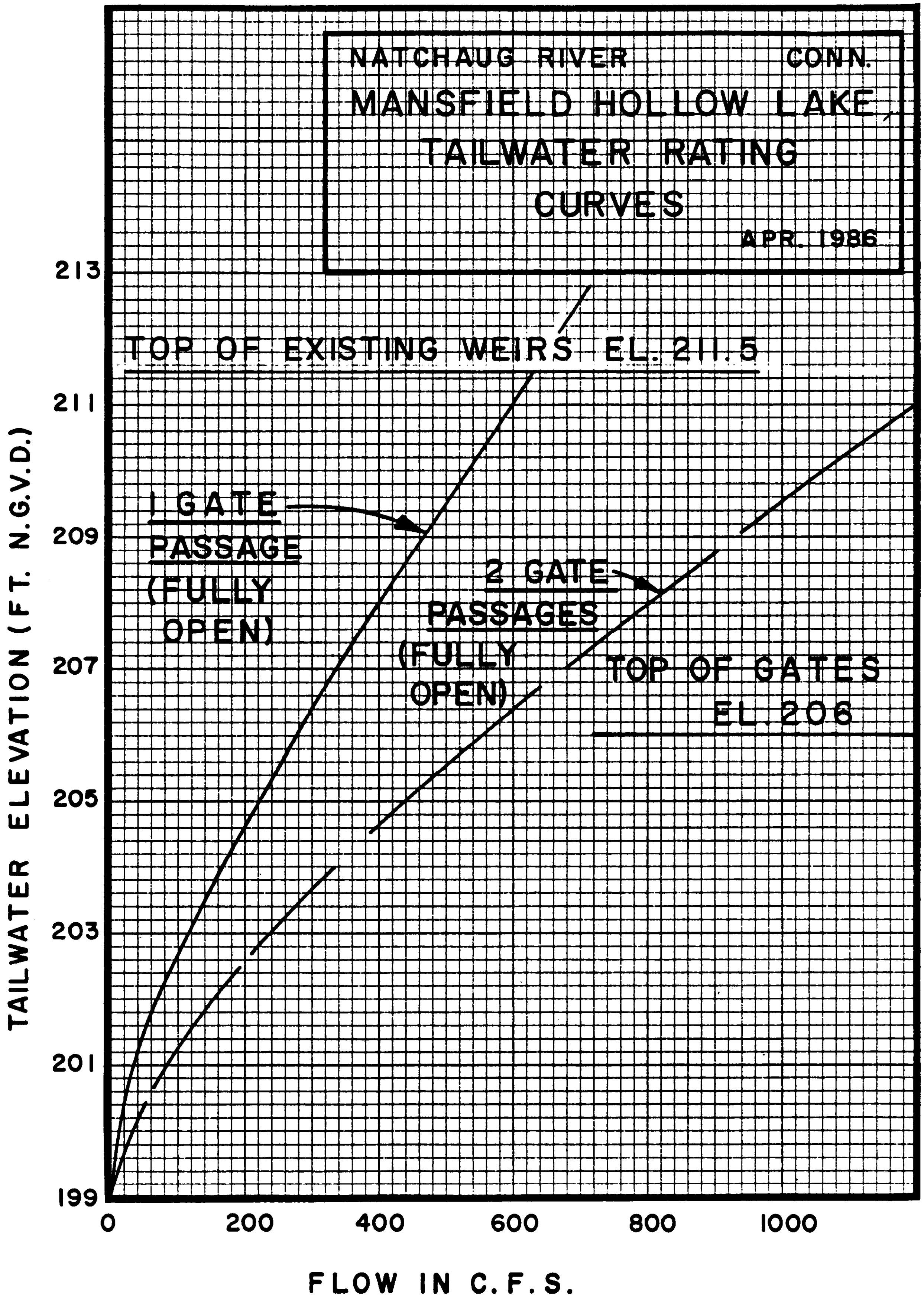
CONCEPTUAL PLANS AND SECTIONS

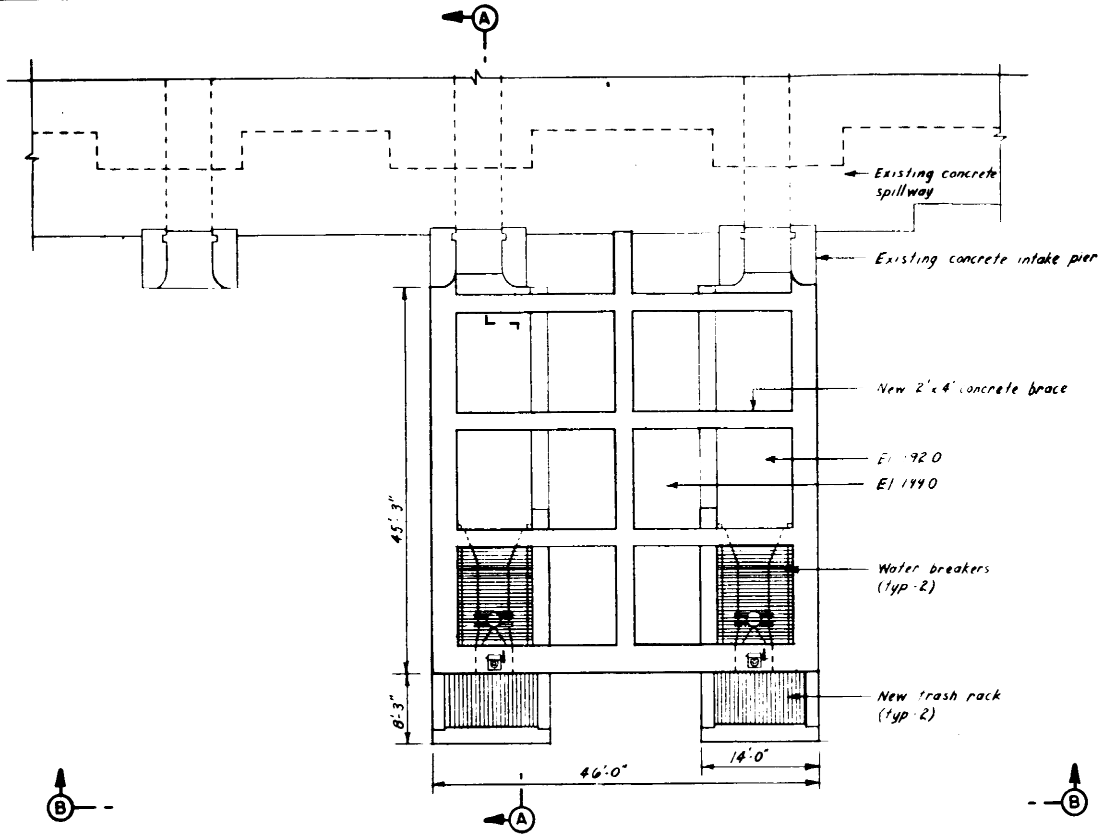
POOL AT EL. 213.0

NATCHAUG RIVER — CONNECTICUT

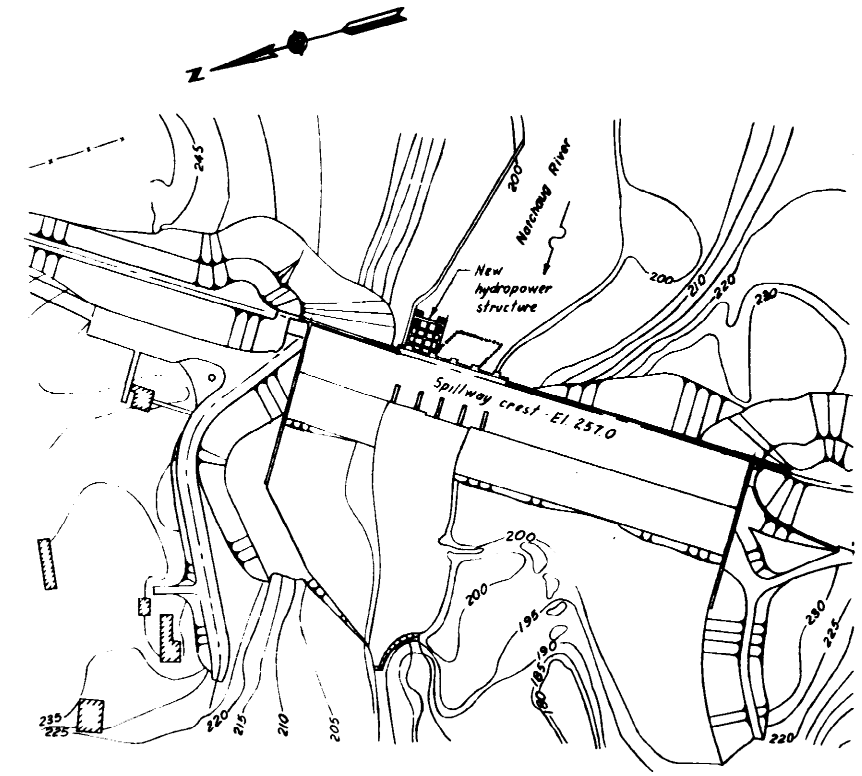
OCT. 1986

PLATE 5

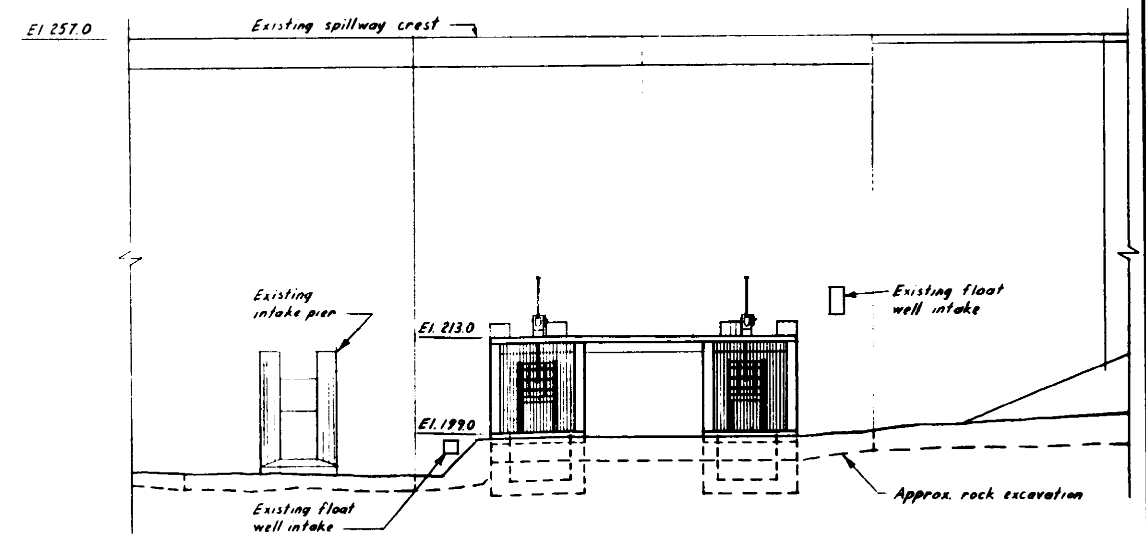

NATCHAUG RIVER CONN.
MANSFIELD HOLLOW LAKE
TAILWATER RATING CURVES
APR. 1986
TOP OF EXISTING WEIRS EL. 211.5
1 GATE PASSAGE (FULLY OPEN)
2 GATE PASSAGES (FULLY OPEN)
TOP OF GATES EL. 206
213
211
209
207
205
203
201
199
0
200
400
600
800
1000
TAILWATER ELEVATION (FT. N.G.V.D.)
FLOW IN C.F.S.



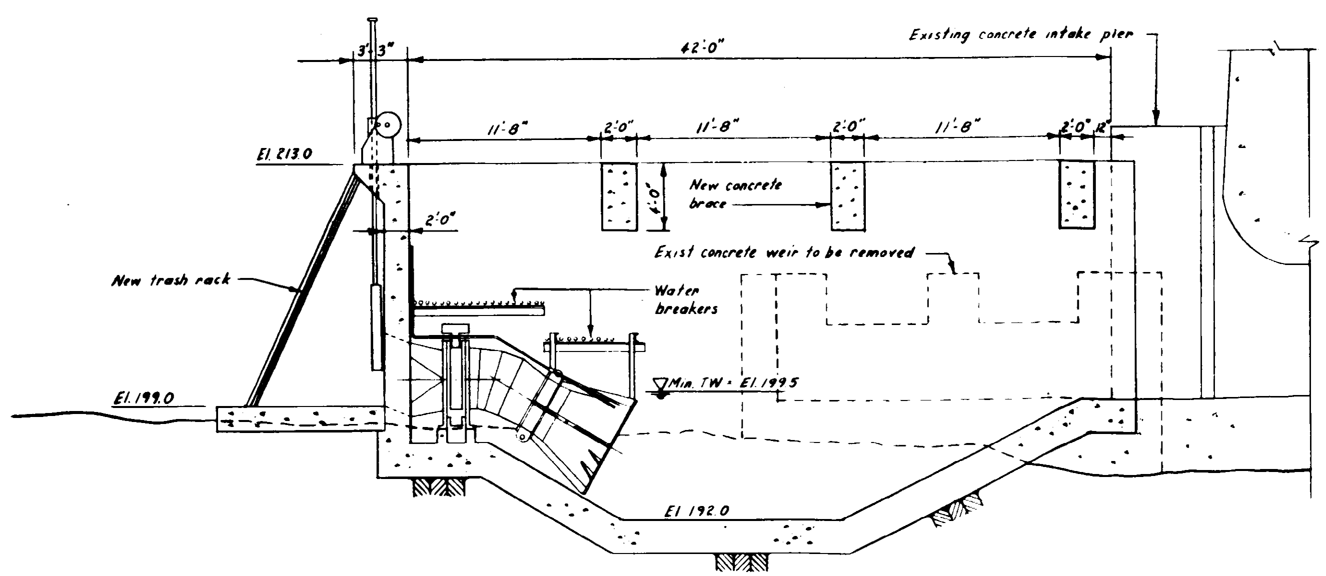
PLAN
SCALE: 1/8" = 1'-0"



GENERAL PLAN
N.T.S.



SECTION B-B
SCALE: 1" = 10'



SECTION A-A
SCALE: 1/4" = 1'-0"

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

HYDROPOWER RECONNAISSANCE STUDY
THAMES RIVER BASIN

MANSFIELD HOLLOW LAKE

SUBMERSIBLE HYDROPOWER INSTALLATION
CONCEPTUAL PLANS AND SECTIONS
POOL AT EL 213.0

NATCHAUG RIVER | AUG. 1986 | CONNECTICUT

TABLE 4
MANSFIELD HOLLOW LAKE HYDROPOWER STUDY
PERTINENT DATA

	Alternative 1	Alternative 2	Alternative 3
Project Description	Downstream	Submersible	Submersible
Units	two	one	one
Pool Elevation	213 NGVD	213 NGVD	213 NGVD
Design Head	23 ft	11 ft	11 ft
Installed Capacity	950 Kw	85 Kw	42.5 Kw
Average Annual Energy	3,300,000 kWh	393,000 kWh	250,000 kWh
Plant Factor	0.40	0.53	0.67
Design Flow	610 cfs	136 cfs	68 cfs

V. ASSESSMENT OF HYDROPOWER ALTERNATIVES

ECONOMIC ANALYSIS

Each of the alternatives was evaluated over a life span of 50 years to determine the annualized cost of the project. The total cost for each alternative includes an allowance for engineering and design, administration, supervision, inspection and overhead (E&D, S&A) and for interest during construction (IDC). E&D and S&A values were determined using standardized curves relating total cost to percentage of total construction cost. Interest during construction values were derived at the Fiscal Year 1986 Federal interest rate of 8-5/8 percent assuming a two-year construction period for the conventional hydropower projects and a one-year construction period for the submersible installations. These total costs were amortized to determine the annual cost of the construction. Values for operation and maintenance (O&M) and replacement costs were added to establish the total annual cost. Cost breakdowns for the conventional hydropower alternatives and the submersible hydropower alternatives are presented in Tables 5.

The methodology employed in deriving the economic value of a hydropower installation utilizes the present market value of the energy produced by the thermal project it would replace. The cost comparison should reflect the construction cost of the existing or proposed project and the annual operating cost over the economic life, expressed as a levelized equivalent annual cost. The levelized annual cost is adjusted to reflect the difference in the escalation rate between the cost of fuel and the general rate of inflation. The value placed on the energy produced at a particular project is in direct relationship to the annual cost of the energy generation it would replace.

The Federal Energy Regulatory Commission (FERC) has the task of assigning values on the power to be produced by a hydropower development under consideration. The FERC accomplishes this utilizing the following method: (1) estimate the resource cost of the most likely thermal alternative to be implemented in the absence of hydropower development, (2) perform a "life cycle cost" analysis for the most likely alternative in which projected fuel cost increases are factored into the total resource cost and (3) measure the "displaced" or "avoided" energy cost that the hydropower addition will accomplish in the existing electrical generation system.

The proposed plan of development at Mansfield Hollow Lake is small in nature and contains no dependable capacity. It is evident that a thermal alternative would not be built in the absence of the construction of this hydropower plant. Based on these factors a "most likely alternative" or a "dependable capacity life cycle analysis" would be impractical. It was determined that the displaced energy method would be most applicable to this project. The displaced energy method estimates the cost of the energy that the hydropower addition at Mansfield Hollow Lake would

TABLE 5

MANSFIELD HOLLOW LAKE HYDROPOWER STUDY
PROJECT FIRST COSTS AND ANNUAL COSTS
ALTERNATIVE HYDROPOWER INSTALLATIONS

	Alternative 1	Alternative 2	Alternative 3
Access	$5,000	$8,000	$8,000
Control of Water	$45,000	$8,000	$7,000
Excavation (general)	$0	$6,000	$3,000
Excavation (rock)	$30,000	$24,000	$10,000
Mass concrete	$36,000		
Reinforced concrete	$81,000	$124,000	$74,000
Trash Racks	$30,000	$20,000	$10,000
Stoplog	$15,000	$3,000	$2,000
Sluice Gate		$42,000	$21,000
Turbine/Generator (including all associated equipment)	$1,800,000	$250,000	$125,000
Interconnection		$50,000	$50,000
Penstock (including support system)	$570,000		
Liners & Bifercation	$150,000		
Butterfly Valve	$135,000		
Station Electrical	$380,000		
Switchyard & Transmission	$100,000		
Misc. Station Equipment	$70,000		
Powerhouse Crane	$30,000		
Sub-Total	$3,477,000	$535,000	$310,000
Contingencies (25%)	$869,000	$134,000	$77,500
Construction Cost	$4,346,000	$669,000	$387,500
Engineering & Design	$435,000	$66,900	$35,000
Supervision & Administration	$326,000	$26,000	$26,000
Projected First Cost	$5,107,000	$761,900	$448,500
IDC	$441,000	$8,000	$9,000
Total Project Cost	$5,548,000	$769,900	$457,500
Interest & Amortization	$486,000	$67,000	$40,000
Operation & Maintenance	$10,000	$1,000	$1,000
Replacement	$21,000	$1,000	$1,000
Total Annual Cost	$517,000	$69,000	$42,000

displace from the existing generation system. The methodology for the displaced energy cost analysis is based on the Water Resources Council's task force report entitled, "Implementing Procedures for Evaluating Hydropower Benefits," dated December 1981.

In simple terms, the benefit under this method is the difference in system costs incurred by a utility (system) to meet a specific demand without the Mansfield Hollow hydropower addition compared to the cost the utility would incur with the Mansfield Hollow hydropower plant meeting part of the demand and the balance supplied by other facilities. To accomplish this, a life cycle cost analysis, utilizing existing energy generating facilities, was performed on the energy displaced year-by-year beginning with 1989, the project on-line date. In this analysis, the projected real price increases of fuel oil were utilized since oil-fired generation would be displaced by the hydropower plant. The annual load duration curves for New England were synthesized from data contained in the Northeast Power Coordinating Council (NPCC), Long Range Coordinated Bulk Power Supply Programs report, and load duration curves provided by the New England Power Exchange (NEPEX). The type of generation displaced was then determined from the capacity band stackings on the annual load duration curve. The projected capacity mix is available from the NPCC reports through the year 2002. After 2002 it was assumed that there would be no further changes in the types of generation displaced. Displaced energy values were calculated by FERC in 1984 for various Corps projects throughout New England. Power values derived for a prior hydropower study were considered applicable for this study based on a comparison of the project's installed capacity and regional characteristics. Recent discussions with the FERC indicated that these values would still be appropriate for planning level investigations. Table 6 shows the displaced energy values provided for Townsend Lake.

TABLE 6

POWER VALUES - DISPLACED ENERGY ANALYSIS

	COMBUSTION TURBINE	CYCLING COAL		BASE-LOAD COAL		
Plant Factor %	10	20	30	40	50	60
Energy Mills/kWh	166	166	154	154	154	154

The displaced energy values were applied to the energy generated at each hydropower alternative to determine the average annual energy benefits for each of the projects. Economic justification was determined by comparing the average annual energy benefits to the total annual costs. The resulting benefit to cost ratio must exceed unity for an alternative to be considered economically justified and eligible for Federal participation. A summary of the economic analysis is illustrated in Table 7.

TABLE 7

MANSFIELD HOLLOW LAKE HYDROPOWER STUDY
ECONOMIC ANALYSIS
($000)

	Alternative 1	Alternative 2	Alternative 3
Installed Capacity	950 Kw	85 Kw	42.5 Kw
Average Annual Energy	3,300,000 kWh	393,000 kWh	250,000 kWh
Plant Factor	.40	0.53	0.67
Energy Value (mills/kWh)	154	154	154
Annual Cost	$517,000	$69,000	$42,000
Cost of Energy (mills/kWh)	156.70	175.60	168
Annual Benefits	$508,000	$61,000	$39,000
Benefit/Cost Ratio	0.98	0.88	0.93

ARCHAEOLOGICAL IMPACTS

The maximum pool level of the recreation pool at Elevation 213 feet NGVD will not be increased due to the proposed addition of a hydropower installation. However, since the operating level of the pool is periodically raised from Elevation 211.5 feet NGVD to Elevation 213 feet NGVD without an archaeological reconnaissance survey, unrecorded prehistoric and historic sites could potentially be present within the affected area.

ENVIRONMENTAL IMPACTS

Effects on the aquatoc ecosystem would result from the construction of the project and the increase in the permanent pool level. However, the impacts to the aquatic system would be minimized since the present recreation pool is periodically increased to the proposed hydropower operating level. Sufficient funding was not available to determine the impact of increasing the pool 1.5 feet.

Construction of a cofferdam will have minimal temporary impacts on the aquatic environment. A very small amount of benthic habitat will be covered and increases in siltation and turbidity which can affect spawning may occur.

Hydropower units can impact fish which approach or pass through them. A number of factors affect fish mortality in hydropower units, these include size of opening, flow rates, operation times, RPMs and design of the intake structure. Generally smaller openings, lower flow rates, shorter operation times, and lower RPMs will result in less severe impacts. These factors would have to be studied in relation to the existing fish populations to determine the most probable impacts and mitigation.

Impacts to the terrestrial ecosystem will be minimized since dewatering is not required and the existing recreation pool is raised to Elevation 213.0 feet during a portion of each year. The noise and disturbance associated with construction may temporarily drive sensitive species of wildlife from the area.

WATER QUALITY

It is expected that cofferdams will be used during construction to avoid dewatering the reservoir. Short term impacts of cofferdam construction would increase turbidity and siltation. Water Quality effects would be carefully monitored since the Willimantic water supply is located downstream.

Long term impacts of a hydropower installation at Mansfield Hollow Lake would include the impact on dissolved oxygen levels in the discharge. The outflow from the lake is currently discharged over a weir. Withdrawal of surface water and the turbulence in the fall over the weir insure that the discharge is well aerated. In as much as the hydropower alternatives involve releases from lower levels in the reservoir and the turbulence over the weir would be lost, the discharge from the project would have lower levels of dissolved oxygen than presently occurs.

RECREATIONAL RESOURCES

No significant impacts to the recreation resources are anticipated since the recreation pool is periodically increased to Elevation 213.0 feet NGVD during the peak recreation period.

VI. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Based on the preliminary findings presented in this appraisal report, it appears that the addition of hydroelectric facilities at the Corps' Mansfield Hollow flood control project is marginally economically feasible. Three alternative hydropower schemes were developed and evaluated using standard economic criteria. Each of the alternatives would utilize the existing recreation pool. Both conventional, downstream hydropower developments and submersible installations, located within the dam's impoundment, were considered for this location.

An economic evaluation was performed for each of the alternatives to determine their benefit to cost ratios. The analysis showed that each of the projects investigated had benefit to cost ratios below unity, however, Alternative 1 had a benefit to cost ratio just below 1.0. Due to the level of detail inherent with an appraisal report, it would be inappropriate to consider this project not economically feasible.

Alternative 1 would consist of a powerhouse located 650 feet downstream of the dam connected to two of the project's outlet conduits by a steel penstock. The project would consist of two units with an installed capacity of 950 Kw, operating under a net head of 23 feet, producing approximately 3,300,000 kWh of energy per year. The project would have a total investment cost of approximately $5,548,000, resulting in a benefit to cost ratio of 0.98 to 1.0.

Preliminary investigations were made on the impacts of the selected hydropower alternatives to the Mansfield Hollow Lake project. These investigations determined that the impacts to the project would be minor. Future studies would be required to determine the archeological, environmental, recreational and water quality impacts associated with hydropower development at Mansfield Hollow Lake.

RECOMMENDATIONS

The primary factor used to determine the Federal interest in any water resources project is the project's net contribution to the national economic development. The principal criteria for determining a project's net contribution is the relationship between the project's accrued annual benefits versus the project's annual cost. The ratio of annual benefits to annual cost must exceed unity for a Federal interest to exist. Of the three alternatives investigated, none of the projects had a benefit to cost ratio above unity. However, one of the alternatives had a benefit to cost ratio approximately equal to unity.

The current administration's policy is to encourage non-Federal interests to develop the hydropower potential where it is feasible and to only pursue Federal hydropower development where such non-Federal activity is impractical. Hydropower development at the Corps' Mansfield Hollow Lake could be pursued under the Federal Energy Regulatory Commission (FERC) procedures, therefore, I recommend no further study of Corps' Mansfield Hollow Lake at this time. However, if future development by Non-Federal is considered to be impractical then additional Federal studies may be warranted.

ACKNOWLEDGMENTS

This study was conducted by the New England Division, Army Corps of Engineers, under the general supervision of Mr. Joseph L. Ignazio, Chief, Planning Division and Mr. Donald W. Martin, Chief, Basin Management Branch. Investigations were performed by an interdisciplinary project team. Persons primarily responsible for the contents of this report were: John Kennelly, project manager; Debora Wilson, hydrology; Townsend Barker, water quality; Robert LeBlanc, design and cost estimates; Lawrence Oliver, environmental conditions.